INVESTIGATION OF FISH KILLS IN ACTIVE PASS, B.C. IN MAY 1983

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Generally, the reports will contain raw and/or analyzed data but will not contain interpretations of the data. Such compilations will commonly have been prepared in support of work related to the programs and interests of the Ocean Science and Surveys (OSS) sector of the Department of Fisheries and Oceans.

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Regional and headquarters establishments of Ocean Science and Surveys ceased publication of their various report series as of December 1981. A complete listing of these publications and the last number issued under each title are published in the *Canadian Journal of Fisheries and Aquatic Sciences*, Volume 38: Index to Publications 1981. The current series began with Report Number 1 in January 1982.

Rapport statistique canadien sur l'hydrographie et les sciences océaniques

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En général, les rapports contiennent des données brutes ou analysées mais ne fournissent pas d'interprétations des données. Ces compilations sont préparées le plus souvent à l'appui de travaux reliés aux programmes et intérêts du service des Sciences et Levés océaniques (SLO) du ministère des Pêches et des Océans.

Les rapports statistiques sont produits à l'échelon régional mais sont numérotés et placés dans l'index à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page de titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Les établissements des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports depuis décembre 1981. Vous trouverez dans l'index des publications du volume 38 du *Journal canadien des sciences halieutiques et aquatiques*, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du Rapport n° 1 en janvier 1982.

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ABSTRACT

Herlinveaux, R.H., F.A. Whitney and J.A. McFarlane, 1986. Investigation of Fish Kills in Active Pass, B.C. in May 1983. Can. Data Rep. Hydrogr. Ocean Sci. 47: iv + 9 p.

A kill of an estimated 15,000 fish in Active Pass occurred over several days during May 1983. It appears to have been a natural phenomenon which has occurred often in the past but has not previously involved such a large number. Investigation into the cause suggests it to be a result of the fast-moving flood tide interacting with the bottom topography of the Pass to bring about upwelling. The fish present in the water at depth are brought to the surface faster than they can adjust to the change in depth. Once on the surface, they cannot return to depth because they are bloated and are probably suffering from the "bends". They therefore become easy prey for eagles and several species of water fowl.

Key words: fish kill, upwelling

RESUME

Herlinveaux, R.H., F.A. Whitney and J.A. McFarlane, 1986. Investigation of Fish Kills in Active Pass, B.C. in May 1983. Can. Data Rep. Hydrogr. Ocean Sci. 47: iv + 9 p.

En mai 1983, on a évalué à 15 000 le nombre de poissons qui sont morts, sur une période de plusieurs jours, dans la passe Active. Il semble que cela soit dû à un phénomène naturel qui s'est produit souvent dans le passé mais qui n'a jamais provoqué auparavant une aussi grande mortalité. Les recherches sur la cause portent à croire que cela serait dû à la marée qui monte très rapidement et qui interagit avec la topographie du fond de la passe pour causer la remontée d'eau profonde. Les poissons présents dans l'eau en profondeur sont amenés en surface plus rapidement qu'ils ne peuvent s'ajuster au changement de profondeur. Une fois en surface, ils ne peuvent revenir en eaux profondes parce qu'ils sont gonflés et qu'ils souffrent probablement due "mal des caissons". Ils deviennent ainsi une proie facile pour les aigles et plusieurs espèces d'oiseaux aquatiques.

Mots-clés: hécatombe de poissons, remontée d'eau profonde

ACKNOWLEDGEMENTS

In an operation of this type, response time is extremely important, especially in mounting resources of equipment and manpower necessary to investigate the problem. On May 18, 1983, the Institute of Ocean Sciences was informed of the event. Ron Kehl, the Victoria Fisheries Service Protection Officer with whom we have worked closely several times in the past, was contacted to arrange a rendezvous with Captain John Bumpas of the M.V. ATLIN POST and to notify the District Fisheries Supervisor, R.A. (Kip) Slater, at Nanaimo Fisheries Office of our intentions. A team of investigators - biologist Sandy McFarland (PBS), chemist Frank Whitney (IOS) and Dick Herlinveaux - were recruited through the efforts of the Ocean Information Division (IOS). This team assembled the necessary equipment on the afternoon of May 18 and was prepared to be at Active Pass the next day in one of the Institute's small fast boats. The CWS and Provincial Wildlife Service were notified because birds were observed eating the dying fish. Dr. D. Mackas, who was on a field cruise in the area at the time, was asked if he could amend his program so that further sampling could be carried out on either side of Active Pass. He complied with this request. Other scientists and technicians at PBS who had been made aware of the problem also provided excellent co-operation and advice. Dr. L.F. Giovando contributed by editing this report.

Introduction

During the week of May 14-20, 1983 at Active Pass (Figure 1), fish were found floating on the surface in a "dazed" and dying condition; eagles and gulls were feeding on them. It was estimated that over a period of seven days at least 15,000 fish had died. The heaviest mortality (an estimated 5,000) occurred on May 15. The fish started to appear on the surface about one-half to one hour after the change to flood tide in Active Pass. The phenomenon also coincided with maximum spring tides in the area.

The fish in question were sampled. Those still alive at capture were found to be in good physical condition but to be "disoriented." They were swimming on their sides. The fish caught, primarily Pacific hake (Merluccius Productus) and Pacific cod (Gadus macrocephalus Tilesius), were placed in shipboard cold storage and taken to Nanaimo to be examined by Pacific Biological Station personnel.

When an originally mysterious fish kill occurs, it has usually been found to be associated with man's activity, e.g., the dumping at sea of trawled scrap fish having little market value at the time.

Sampling Program

However, there are in fact many factors, other than the one noted above, which could result in a fish kill. Parasitic infestation, toxic plankton, predation, and physiological or chemical processes resulting from natural and/or man-made events may all contribute, alone or in concert. Therefore, a sampling program, as intensive as possible considering the short notice, was laid down to measure several variables throughout the water column in the Active Pass area. Five stations, involving three locations (Figure 1), were occupied over a one-day period. Times and depths of the physical oceanographic measurements are given in Table I. These consisted of the following:

1. Dissolved oxygen, salinity, temperature, chlorophyll and turbidity.

2. Plankton: phyto- and zoo- (distribution and number of species).

3. Fish themselves.

4. Biological life (other than plankton) (by echo-sounder).

Results and Observations

(a) The water samples indicated there was no deficiency in oxygen at any level. The temperature/salinity results indicated that the water in the Pass was from subsurface, especially on the flood.

(b) The plankton samples indicated no plankton which could cause death or stress to the fish. An example of such phytoplankton, Chaetoceros Noctiluca (a "pin-cushion" type), can get enmeshed in fish gills. As a result, the gills can become infected and secrete mucous; fish so affected can often die of pneumonia.

(c) The fish appeared not to have been affected by parasitic infestations Copepods have been known to attach themselves to the gills of fish, a condition which can result in death. Some parasites may weaken a fish during certain times of the year; the ensuing stress can in turn make the fish vulnerable to other stresses that they would normally withstand successfully.

(d) The echo-sounder traces indicated fish lying both in the trough on the south side of the Pass (running WNW from Enterprise Reef - see Fig. 1), and in a small hole NW of the trough.

(e) A "scattering" layer, Figure 2a (60 m), presumed to be composed of zooplankton above the fish noted in (d), was present when we first arrived on the scene (1630 hrs), but appeared to migrate or diffuse upward around 1700 hrs. This upward movement of the layer could have represented the beginning of a diurnal migration which would be followed by an upward movement of the fish. Within one-half to one hour, the fish (horseshoe-shaped targets) appeared to have moved upward from the trough (60-100 m) to mid depth (40-60 m) and shallower. Other traces showed fish to be present at the mouth of Active Pass (south side), presumably either transported upward by the inward-moving upwelling flood and/or moving upward on a diurnal migration following that of the scattering layer. The fish population, as sampled from specimens retrieved from the surface waters, ranged in age from 2-15 years; the number of males and females was approximately equal. It appears therefore that there was little or no selectivity characterizing whatever was causing the fish deaths.

(f) Turbidity profiles showed there was a heavy "bloom" on both sides of the Pass. The "bloom" extended to 18 metres depth on the south side, and to about 22 metres on the "north" side of the Pass. At depths greater than about 22 metres the water column was relatively clear at both sides of the Pass. No suspended material was evident in the "trough" noted in (d).

(g) Marine bird life, especially Bald Eagles, have been known to frequent the Active Pass area as long as people can remember. As many as 40 such eagles have been sighted at one time in the area. They nest there presumably because fish are often plentiful and are taken as food.

Earlier current studies in Haro Strait have indicated that the flood tide can be moving inward (northerly) along the bottom as much as one-half hour before the corresponding occurrence at the surface. This difference in water movement with depth results in the transport of dense water along the bottom of the Strait; this water acts like a wedge, displacing previously resident fluid upward.

In southern Haro Strait, earlier work (Huggett, 1966) indicated that throughout the flood the bottom current (at 136 m) was actually faster than the corresponding movement at the surface. In effect, a "jet" of dense water moves north through Haro Strait displacing bottom water ahead of it. Because of the topography, this displaced water can surface at Active Pass, resulting in upwelling and large slick areas just inside the southern end of the Pass.

Hake are weak swimmers and meandering-type feeders, and are lethargic in their movements. If these fish were exposed to the fast-moving flood-tidal waters moving (at 3-5 kts) within the trough, they would experience a relatively rapid, upward movement to the surface in the Pass. This rapid rise (from about 70 to 0 m), which calculations show could occur in as little as four minutes at these speeds, would result in the fish experiencing bloating and possibly the "bends". As a result of the deleterious effects from the rapid change in pressure, they would have extreme difficulty in returning to depth. Once on the surface, and in a weakened condition, they would be seized easily by sea birds and eagles.

Discussion

On many occasions in the late 1940s, eagles fishing in the area of Active Pass were noted by one of the authors who was, at the time, commercially fishing for herring bait. This viewing was from some distance away, and it was assumed that the eagles were feeding on herring and salmon. However, there is a good possibility that they were feeding on hake undergoing a process similar to that proposed here.

It is therefore suggested that this type of fish kill occurs frequently, especially on larger tides during the spring at which time hake are known to frequent the area, probably in migration.

It is suggested that the number of fish involved in a kill could vary seasonally. If, for example, it is influenced by denser water intruding into the Strait of Georgia as far as Active Pass, then kills would start as early as March, a transitional period of the year, at which time an onshore movement of dense bottom water occurs. This increase in the density of bottom water generally continues until July; subsequently, a decrease in density is experienced at depth.

The number of fish killed is probably also determined to some degree by the availability of the fish themselves; therefore the degree of kill may vary with the season since abundance will vary, as a result of, for example, the degree of migratory activity.

The time of flood tide with respect to the diurnal migration may also determine the number of fish killed. For example, if the flood tide occurred at the end of the day - when the diurnal migration most commonly takes place - more fish would probably be available to be transported upward into the Pass.

Possible Topics for Future Study

Confirmation of the basic hypothesis put forward to explain this fish kill - namely that the affected fish have undergone the "bends" - would require a study involving, for example, examination of freshly-killed fish for gas bubbles in the joints and/or around the brain and gills. Such a study could be carried out by a specialist at the Pacific Biological Station.

A further, and relat ely economical, way to reinforce the suggestion that the kill is basically a seasonal event would be to study the seasonal

variation in the number of eagles present in the area. If there is no such variation in the size of fish kill, the number of eagles in the area will be litte different throughout the year. Otherwise, the eagles will probably move elsewhere during the "lean" periods. The possibility of having the B.C. Ferry Corporation carry out eagle counts as their vessels move through Active Pass should be investigated.

Figure 1 Shows the underwater topography of Active Pass and location of sampling stations

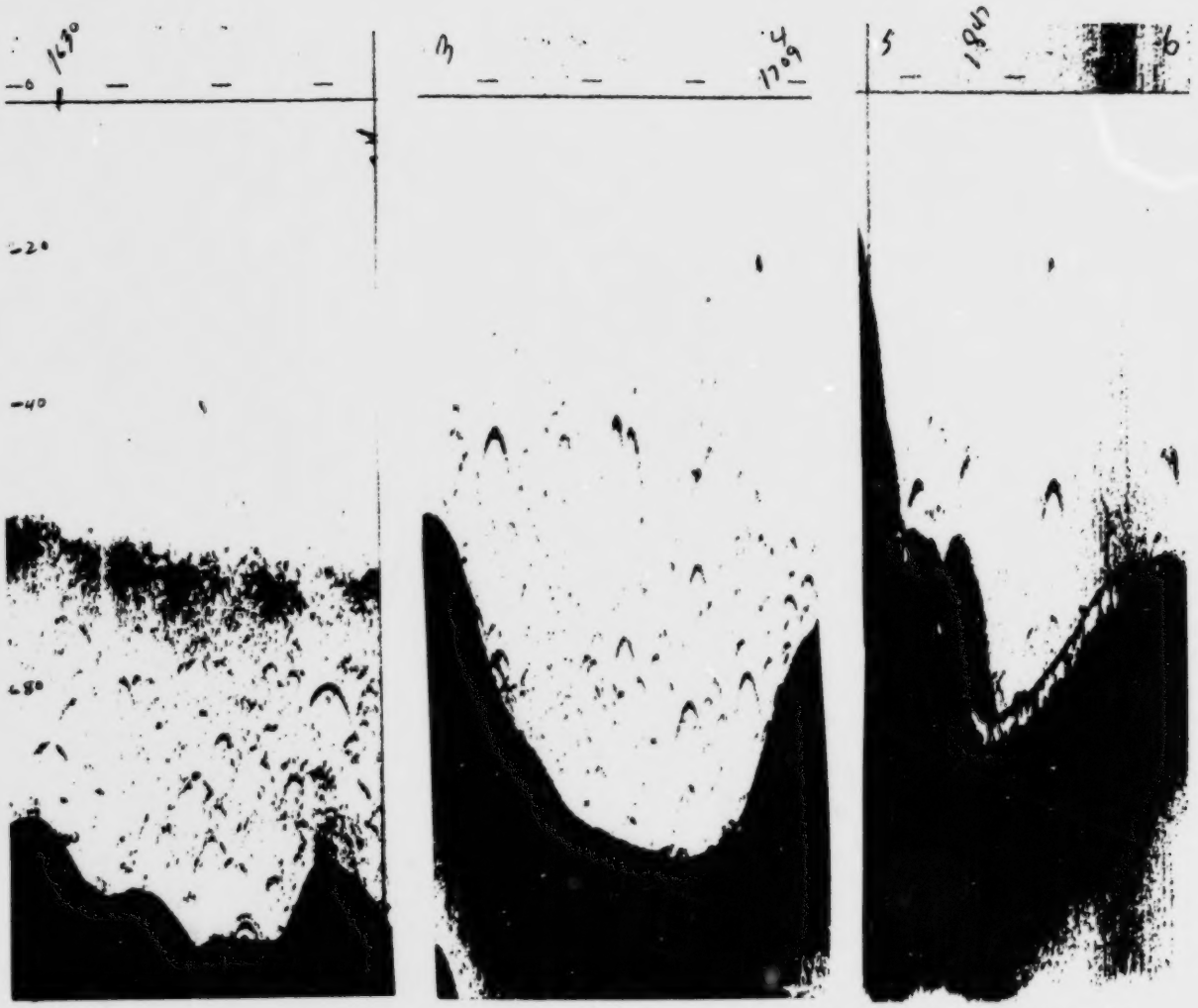

Figure 2 Echo sounder trace taken at (a) outside Active Pass in Trincomali Channel 16:30 (b) 17:09/19/5/83 and (c) mouth of Active Pass 18:47

TABLE I

Station 1 Date 83-06-19 Time 15:45 DST
Position 48°51.8'N 123°20.3'W Bottles

Depth	Temp (C)	Sal (S%)	O_2ml/l
0	11.40	26.37	6.45
10	11.14	26.67	6.34
20	9.99	28.11	5.78
30	9.51	28.58	5.58

Station 2 Date 83-06-19 Time 17:30 DST
Position 48°50.6'N 123°21.2'W Bottles

Depth	Temp (C)	Sal (S%)	O_2ml/l
0	10.75	27.75	6.72
25	10.05	28.99	5.90
50	9.78	29.86	5.47
60	9.75	30.04	5.40
75	9.56	30.53	5.17
100	9.48	30.90	5.01
110	9.47	30.93	4.98

Station 3 Date 83-06-19 Time 20:15 DST
Position 48°51.8'N 123°20.3'W Bottles

Depth	Temp (C)	Sal (S%)	O_2ml/l
0	20.24	23.98	6.15
10	10.18	28.98	6.13
20	10.14	29.16	6.07
30	10.12	29.21	6.02

Station No. 4 Date 83-05-20 Time 12:42
Position 48°53.6'N 123°18.2'W STD 92 records on file

Depth	Temp (C)	Sal. °/oo	CHL Amg/m^3	XMS	LT(uE/m^2/S)
0	12.17	25.76	1.99	75.27	1709.2
5	11.42	26.63	2.84	77.95	458.3
10	10.93	27.28	3.00	79.65	120.4
15	10.55	27.69	2.60	79.65	21.4
20	10.39	28.08	2.36	78.08	8.0
30	9.55	29.02	1.10	77.16	-1.2
50	8.73	29.31	.23	85.27	-1.2
75	8.89	29.64	.34	84.11	-1.2
100	8.99	29.94	.33	81.37	-1.2
125	9.04	30.22	.28	79.34	-1.2
130	9.06	30.32	.26	79.41	-1.2

Station No. 5 Date 83-05-20 Time 13:19
Position 48°50.6'N 123°21.2'W STD 82 records on file

Depth	Temp (C)	Sal. °/oo	CHL Amg/m^3	XMS	LT(uE/m^2/S)
0	12.08	28.28	9.04	61.72	1709.2
5	10.55	28.59	13.35	65.69	269.5
10	10.16	28.69	3.53	74.61	42.7
15	10.10	28.95	4.53	75.07	10.1
20	10.00	29.20	2.42	74.54	.9
30	9.88	29.59	2.34	73.06	-1.2
50	9.56	30.56	.87	71.92	-1.2
75	9.43	31.00	.877	67.75	-1.2
100	9.37	31.18	.94	64.63	-1.2
121	9.37	31.21	.93	64.92	-1.2

NOTE: CHLAmg/m^3 - Chlorophyl A, in milligram per $metre^3$
XMS - Percent light transmitted per metre
LT(uE/m^2/S = Micro Einsteins per $metre^2$ per second
1 Einstein = 6.02×10^{23} quant $350\text{-}700 \times 10^{-9}$m.
$\backsim$ 0.43 of total radiation

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